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BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

ADDITIONAL INFORMATION CONCERNING TREE MEDICATION AS A CONTROL OF THE MOUNTAIN PINE BEETLE IN WESTERN WHITE PINE

by

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Respectfully submitted

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PREVIOUS INVESTIGATION

For the past several years, forest entomologists have experimented with tree medication as a means of controlling bark-beetle infestations; but it was not until 1930 that attempts were made to use this method to destroy mountain-pine beetle broods in western white pine trees. An account of the 1930 work and of that during the two subsequent seasons are available in a report by Gibson and Bedard.[1] Briefly, this report

[1] Gibson, A. L., and Bedard, W. D., - 1933 Tree medication as a control of the mountain pine beetle in western white pine. Manuscript in the Forest Insect Field Station at Coeur d'Alene, Idaho.

shows the following:

1. Western white pine trees infested with the mountain-pine beetle were injected with poisonous solutions.

2. Solutions containing sodium arsenate were most successful and resulted in 100 percent brood mortality.

3. The most simple was an aqueous solution comprising one-fourth pound of sodium arsenate (technical crystals) and three quarts of water.

4. After injection, this solution was eventually distributed throughout the tree as high as 160 feet.

THE 1933 STUDIES

Thirty-one trees were medicated during 1932, but were not examined until the spring of 1933 because it was previously learned that complete mortality does not occur until the spring following injection. These trees were medicated with three objectives in view: first, to evolve a simpler method of injection; second, to ascertain the least amount of poison and solution necessary to secure 100 percent brood mortality;

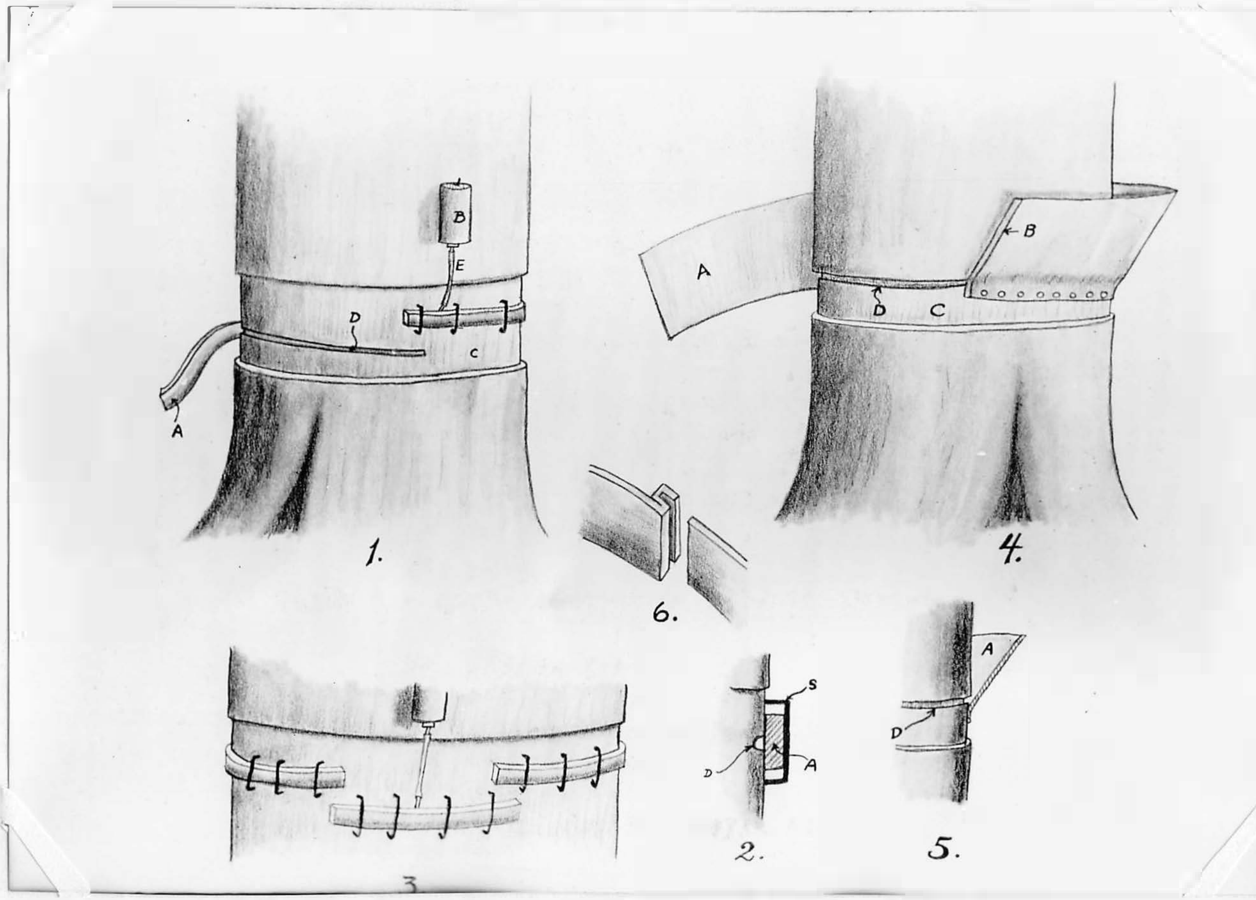
and third, to learn how long after attack a tree could be treated successfully.

Methods of Injection

Best results were secured by using the saw kerf-tin collar method of injection. This is applied (Plate I, figs. 4, 5, and 6) by girdling the tree with a shallow saw cut. A strip of bark about 3 inches wide is then removed below and adjoining the cut, so that a smooth surface is secured for attachment of the collar. The collar consists of a strip of tin which when nailed on the bottom edge, flares away from the tree and forms a trough. The two ends of the tin are joined by an S-shaped flange, and in order to prevent leakage, a thin layer of cup grease is used along the joint and also where the collar is nailed to the tree.

It was felt, however, that this method required too much skill, when properly applied, to be used in control projects. Hence, during the 1932 studies attempts were made to perfect a simpler technique of injection. One of the methods tested consisted of a saw cut girdling the tree, a long piece of wicking, and a jar of poison. The wicking completely filled the saw cut and one end extended to the jar of poison. Two trees were treated in this manner, but upon examination in 1933, it was found that no brood mortality had occurred.

A second variation consisted of a series of tangential holes bored completely around the tree as close to the surface of the wood as possible. All holes leading to the outside were stopped with corks fitted with copper tubing and poison solution was supplied in tin cans which were connected with the copper tubing by short pieces of rubber. Of the three trees injected in this way, only one showed an encouraging amount of brood mortality, although all three trees possessed green foliage and living phloem at the time of injection. Exactly what caused the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variation in mortality is not known but possibly it was due to improperly placed holes, or to some variable mechanical property of the wood. However, as partial results were secured, three more trees were so medicated during 1933. The method was modified somewhat however, in that one tree was injected in the roots.

Dr. Craighead and Mr. St. George supplied the technique for another method of injection which consisted of holding the solution in the saw cut by stapling a rubber band securely over the cut and supplying the poison by means of a tin can connected to the cut with copper and rubber tubes (Plate I, figs. 1, 2 and 3). In the application of this method, it was found more feasible to make the cut with a surveyor's scribe instead of a saw so as to facilitate the circulation of solution around the tree. The ends of the rubber are not joined, but are sealed by stapling them securely to the tree as shown in Plate I, fig. 1. When the tree is of such dimension as to require more than one rubber to go round it, the bands are staggered, thus necessitating one can to supply the poison for each band. A special rubber band was provided for this work which was 29"x1$\frac{1}{8}$"x$\frac{3}{8}$", and was stretched twice its length when applied to the tree. A total of 87 trees were medicated in this manner during the 1933 studies, but will not be examined until the spring of 1934.

<u>Minimum Amount of Solution Necessary</u>

To determine the minimum amount of poison solution necessary to destroy all of the mountain pine beetle brood in an infested tree, 15 trees were injected during 1932 with various amounts and concentrations of sodium arsenate solution. The solutions were, 1/8 pound sodium arsenate to 1, 2 and 3 quarts of water; $\frac{1}{4}$ pound sodium arsenate to 1, 2 and 3 quarts of water; $\frac{1}{2}$ pound of sodium arsenate to 1, 2 and 3 quarts of water. Upon examination of these trees in 1933, it was found that $\frac{1}{4}$ of the poison is the least that can be

used for a successful injection. The required amount of water varies as to the size of the tree. Three quarts of water should be used for trees over 30 inches dbh., two quarts for trees between 11 and 20 inches dbh., and one quart is sufficient for trees under 10 inches.

<u>Age of Attack vs. Successful Injection</u>

It is apparent that the practicability of this method of control is dependent in great part upon how soon after attack it is necessary to inject the trees in order to secure 100 percent brood mortality. Obviously, if it is necessary to treat the trees within a few days after attack, the method could only be used on small, maintenance control projects, whereas, an allowable lapse of 50 days or more would permit of its use in large projects.

In Table I, data from the trees examined during 1933 have been arranged in groups according to the age of attack, and the brood mortality secured by medication is shown for each of these groups.

Table I

BROOD MORTALITY SECURED IN VARIOUS AGED ATTACKS

Days elapsed from attack to injection	1 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60
Average mortality percentage	100	100	100	100	70	85

The low mortality secured in trees medicated from 41 to 50 days after attack is due to two trees, one showing 80 percent mortality and the other only 2 percent. The cause of this is not known, but in all probability the fault lies in an improperly applied collar which leaked and therefore did not provide sufficient poison for the tree. However, it is believed that complete control can be secured in trees up to 50

days after attack, and that a high percentage of the brood will be killed in trees injected from 51 to 60 days after attack.

In order to have a more thorough check on this important point, 8 trees were selected at the time of attack during the 1933 studies. Two of these trees were medicated 30 days after attack, two 40 days after attack, two at 50 days, and two 60 days after attack. All of the trees were injected by means of the saw kerf-tin collar method with ¼ pound sodium arsenate and 3 quarts of water. Examinations will be made in the spring of 1934.

Other Studies

In order to avoid the use of arsenicals as insecticides, certain non-arsenic poisons were tested during the 1933 injections in order to discover one which gave results comparable to sodium arsenate. Two trees were medicated with ¼ pound of sodium flouride dissolved in 3 quarts of water; 2 trees with ¼ pound sodium fluosilicate in 3 quarts of water (this chemical was found to be only slightly soluble in water); 2 more trees were medicated with a solution ¼ pound of bichloride of mercury in 3 quarts of water. Dr. Craighead and Mr. St. George suggested the use of the mercuric chloride as they secured good results from this chemical in the medication of southern yellow pines and it was furthermore stated that the wood in trees so injected was preserved from blue stain, woodrots and woodboring beetles for several years after injection. All trees were injected by the saw kerf-tin collar method and will be examined in 1934.

EFFECT OF MEDICATION ON PARENT BEETLES

Although the injection of white pine trees with sodium arsenate solution destroys the immature stages of the mountain pine beetle beneath the bark, the exact effect on the parent beetles has not been ascertained.

From studies made in 1932, it was learned that although some of the parent beetles emerged from medicated trees, a large number of those emerging died without making another attack, while the remaining beetles attacked green material provided for them.

In the spring of 1933, while examining the 1932 medications, records were made of the amount of parent adult emergence in medicated trees. It was found that there was an average of 8.6 emergence holes per square foot of bark surface as compared with 12.1 holes in unmedicated trees. However, only a few of these emerging beetles will attack other trees so that the amount of parent adult emergence from medicated trees is not sufficient to constitute a serious drawback to this method of control.

Special attention was given in these examinations to any correlation between the amount of parent adult emergence and the length of time elapsing between attack and injection. The least number of parent adult emergence holes (4 per square foot) was found in the trees medicated from 21 to 40 days after attack; the greatest number (10 per square foot) in trees medicated from 1 to 20 days after attack; and 7.7 per square foot in trees medicated from 41 to 60 days after attack. However, the data are not sufficient for a definite statement at this time, and similar records will be made in the 1934 examinations.

AN EXPERIMENTAL TREE-MEDICATION CONTROL PROJECT

Organization and Cost

The final test of the practicableness of any method of bark-beetle control is to submit it for trial to the type of men ordinarily employed for control projects. Therefore, $3,000 of the Emergency Conservation Fund were made available on September 6, 1933, to test tree medication as a control method by actually instituting a small project. As previous

studies had shown that to secure best results from medication, the trees should be treated within 60 days after attack, the need for haste was paramount, because most of the attacks had occurred during July. Consequently, the following three days were spent in securing equipment and supplies and the hiring of men. Camp was moved in on September 10th and was located in the center of the infestation on Stoney Creek near Metaline Falls, Washington, on the former Kaniksu National Forest. The camp was only 2 miles from the road so that a packer with one horse and two mules easily maintained it in supplies and equipment.

Organization was on a 20-man basis, with one cook, one flunkey, one packer, two 6-man spotting crews and one 5-man treating crew. A spotting crew consisted of one compassman, four spotters and a chief spotter who followed the crew to check on trees missed and to decide whether or not a tree should be marked for treatment. One foreman and four laborers comprised a treating crew. The organization of the treating crew varied according to the method of treatment being used and in addition, other changes were made to test the feasibility of various organizations. These variations will be described later under a discussion of costs.

When sufficient trees had been marked for treatment, one spotting crew was transferred to treating so that for the greater part of the project there were two treating crews and only one spotting crew. This gives a better basis for the averaging of cost figures, because the original crew may or may not have been an average crew.

A detailed account of costs is given in the following tables:

COST REPORT

Tree Medication Project

Period of work - September 10, 1933 to October 4, 1933

Acres spotted -	1923	Acres treated-	1923
Number trees spotted -	433	Number trees treated -	433

Trees per acre - .225

Total allotment		$ 3,000.00
Total cost of project	$ 1,876.95	
Property remaining*	151.25	
Total expenditure		2,028.20
Balance **		$ 971.80

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* This is the value of materials left from the project which can be used in future work; and includes a deduction of 2/3 the value of equipment, as only 1/3 of the equipment was charged to the project.

**Approximately $400.00 of this balance will be used in the spring of 1934 to defray the expenses of examining the trees treated during this project.

Classified Expenditures

		Total	Per Tree	Total	Per tree
Labor	Camp	$119.40	$ .273		
	Spotting	468.30	1.081		
	Treating	379.80	.877		
				$ 967.50	$ 2.231
Subsistence	Cookhouse	141.10	.325		
	Supplies	289.83	.669		
				430.93	.994
Transportation				224.81	.519
Equipment				11.59	.026
Materials				203.24	.469
Miscellaneous				38.88	.089
Total				$ 1876.95	$ 4.328

Subsistence and Cookhouse

	Cost	Meals served	Cost per meal
Subsistence	$ 289.83	1337	$ .217
Cookhouse	141.10	1337	.105
Total	$ 430.93		$ .322

After examining the preceding tables, it will be seen that the cost per tree on this project compares quite closely with the cost per tree on other projects involving the treatment of western white pine trees. However, it must be remembered that the cost of any control project is dependent upon several variable factors and therefore is not a sound basis upon which to compare one project with another.

Comparison with Other Projects

Therefore, under these circumstances the fairest comparison of methods would probably be on the basis of trees per treating man day. On this basis, only two variables are involved: (1) the human element, and (2) the type of infestation, that is whether the trees are grouped or scattered. In these two factors, the medication project would strike a fair average, the trees being partly grouped and partly scattered, and the inclement weather having reduced the daily production to a fair mean. The following table gives a comparison of the output on this project with that secured on the Kootenai and Coeur d'Alene National Forests. The Kootenai figures are an average of 3 years control work involving 5 projects, and the Coeur d'Alene averages 8 projects during the past five years. As two injection methods and several different treating crew organizations were tested in the medication work, the one giving best results is used in the following table:

Comparison of Treating Man-Day Production for Various Projects

Project	Kootenai	Coeur d'Alene	Tree Medication
Trees per treating man day	2.00	2.17	6.26

It can readily be seen that by using the method and organization which proved most feasible in this experimental work, the cost of any control project in western white pine would be materially reduced. Comparisons of the other crew organizations and injection methods which were tested are given in the following sections.

Comparison of Methods

Only the saw kerf-rubber band method and the saw kerf-tin collar method were used for the injection of the trees treated during this project. A comparison of these two methods on the basis of application shows that a"rubber-band tree" requires approximately three-fourth of the time necessary to inject a tree by the tin-collar method. However, two men are required to stretch and fasten the band, whereas one man can attach the collar. This is reflected in the man-day production, as the crews averaged 3.2 trees per treating man-day when using the rubber bands as compared with 4.73 trees per treating man-day when using the tin collars.

Regarding the costs of the two methods, the rubber-band trees were treated at an average cost of $5.14 per tree, while the "tin-collar trees" averaged $4.12 per tree. The higher cost of the rubber-band trees is due to the higher labor charge and the extra amount of materials necessary to medicate with this method. As an example, an itemized list of costs is given below for the medication of a white pine 32 inches dbh.

Rubber-band Method		Tin-collar Method	
2 rubbers	$ .50		
2 cans	.70		
2 ft. rubber tubing	.02		
2 Copper spiles	.06	1 collar	$ .34
staples	.01	nails	.01
grease	.02	grease	.02
poison	.15	poison	.15
labor	.84	labor	.66
subsistence etc.	2.98	subsistence etc.	2.98
Total Cost	$ 5.31		$4.16

It will be noted that a tree of this size required two of the 29-inch rubbers, thus necessitating the use of two cans to hold the poison. If the rubber were in long lengths, considerable waste would be avoided because just enough rubber would be used for each tree and only one can would be necessary to supply the poison. Also, the ease of application would be considerably increased, not only in the preparation of the tree, but the men would have sufficient room to grip the rubber for stretching, thus eliminating the "grip end" which of necessity was wasted during the project. A further reduction in costs would be secured if a cheaper can were used. Although cans were collected and used again for the Stoney Creek work, the cost of doing this on a larger project would be prohibitive. In all, the actual reductions in labor and materials would amount to approximately 80¢ so that trees could be medicated by this method for $4.50 per tree with an increase in production to approximately 3.9 trees per treating man-day.

The men employed on the project grew quite adept in the application of the bands and the collars and it was surprising to see the ease with which they mastered both methods. In a comparatively short time they learned to splice tin in order to use the extra pieces cut from the

larger collars; they also learned to use the "double-deck collar" in order to avoid a deep "cat-face", and to attach a collar to a badly convoluted tree without having an undulating collar too far away from the saw kerf. They preferred the tin to the rubber for two reasons: (1) The tin required less equipment to be carried through the woods, and (2) they could apply a tin collar, check it and proceed to the next tree without fear of subsequent leaks. In using the rubber it was found necessary for the foremen to check over the trees from time to time during the day in order to stop leaks which had started after the tree had been examined by the treater.

Comparison of Crew Organizations

One of the objectives of this experiment was to determine as nearly as possible the most efficient treating crew organization for this method of control. The original organization was on a five-man basis and when using the rubber-band method, it was found almost impossible to deviate from the 5-man treating crew without a decreased production. In the crew, one man prepared the tree; that is, he made the saw cut and peeled as much of the tree as was necessary, one man stretched rubbers, one man stapled the rubbers to the tree, one man carried water, mixed poison and plugged leaks, and the foreman located new trees, helped prepare the trees and in general helped out wherever needed.

Both 2-man and 3-man crews were tried, using the rubber band method. However, the 2-man crew had too much equipment to carry and the work arranged itself in such a way that one man was often waiting for the other. The 3-man crew proved better, but could not equal the man-day production of the 5-man crew. Compared on the basis of output per

treating man-day, the 5-man crew gave 3.5 trees; the 3-man crew, 3.1 trees; and the 2-man crew, 2.8 trees.

In using the tin-collar method only the 5-man crew and the 2-man crew were used. The 5-man crew was organized with one man to prepare the trees by cutting the saw kerf and peeling a 3-inch strip below the cut; two men (each working on separate trees) attached the collars; one man carried water, mixed poison and plugged leaks; and the foreman located new trees, helped prepare the trees and in general helped out wherever he was needed. It was found that one man preparing trees could prepare a sufficient number for two men, when either the rubber-band or tin-collar method was used.

The 2-man crew proved best of all when working with the tin collars. Man-day production was considerably increased with the resultant lowering of the cost of treatment. Using a 5-man crew the production was 4.23 trees and the cost was $4.27 per tree to medicate by the tin-collar method; using the same method and a 2-man crew the cost was reduced to $4.00 and the output increased to 6.26 trees per man-day. It is most economical, therefore, to use the tin-collar method with a 2-man treating crew.

Spotting crews were organized similar to those used in other white pine projects; a compassman who kept the course and mapped the area, trees, etc.; four spotters, two on either side of the compassman, each of whom cruised a strip one chain wide to locate and mark all infested trees; and a chief spotter who ranged behind his crew to watch for missed trees and to check on each tree located by the spotters.

Results

As the medicated trees will not be examined until the spring of 1934, nothing can be said regarding the amount of control secured from

this project. However, the work has shown quite definitely that ordinary woodsmen can apply both the rubber bands and tin collars successfully, and that the actual cost of treating western white pine trees by this method is less than the cost for methods now being used. The greatest advantage of tree medication, besides its lower cost, is that it eliminates the use of fire in the woods.

SUMMARY

1. Previous investigation has shown that 100 percent of the mountain pine beetle brood infesting a western white pine tree can be destroyed by injecting the tree with an aqueous solution of sodium arsenate.

2. Several methods of injection were attempted, but the saw kerf-tin collar method was found to be most successful.

3. Indications are that infested trees must be treated within 60 days after attack and that the minimum amount of poison necessary to kill 100 percent of the brood is 4 ounces of sodium arsenate dissolved in 3 quarts of water.

4. Although some parent adult beetles emerge from the medicated trees, the percent of those which attack again is not sufficient to constitute a serious drawback to this method of control.

5. A control project using tree medication as the method of control showed that both the rubber-band and tin-collar methods could be applied successfully by ordinary woodsmen.

6. Various treating crew organizations were tested and it was found that using the rubber bands, a 5-man crew gave best results. However, using tin collars, a 2-man crew proved most feasible.

7. The various methods of injection and crew organization gave different results as to cost and treating man-day production. The most economical treatment was secured from a 2-men crew using tin collars, the cost being $4.00 per tree, and the output being 6.26 trees per treating man-day.